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TANGANYIKA TERRITORY.

DEPARTMENT OF AGRICULTURE

Annual Report

1929/30.

PART II.

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TANGANYIKA TERRITORY.

DEPARTMENT OF AGRICULTURE

ANNUAL REPORT 1929/30.

PART II.—AGRICULTURAL INVESTIGATION.

Morogoro Agricultural Station.
Mpanganya Agricultural Station.
Ibadakuli Agricultural Station.
Botanic Gardens, Dar es Salaam.
Report of the Entomologist.
Report of the Mycologist.

DEPARTMENT OF AGRICULTURE

REPORT FOR 1929/30.

For convenience this Report is divided into two parts: Part I dealing with Agricultural Administration and Progress, and Part II, which follows, the Agricultural Investigation that has been carried out during the period.

MOROGORO AGRICULTURAL STATION.

Morogoro District.

The following paragraphs contain an account of the experiments with annual crops carried out on the Morogoro Agricultural Station. The work has been a continuation of the experiments of previous years.

2. The 1929 season was the worst, in respect of rainfall, recorded for many years. The following was the monthly precipitation, in millimetres: —

January...	60·9
February	25·0
March	130·8
April	105·9
May	36·6
June	21·7
July	13·3
August	18·0
September	18·5
October	11·7
November	23·1
December	196·9
Total ...	662·4 millimetres or 26·49 inches

The average rainfall over the previous thirteen years was 965 millimetres, or 38·60 inches.

3. *Cotton: Distance of Sowing Experiment.*—As in previous years all plots were sown on the same day (3rd March, 1929). All rows were three feet apart and spacing in the rows was an shown in the following table of results. The experiment was carried out in duplicate.

Distance of Planting	Number of plants per hill	Acre yields in lb. seed cotton	Comparative results
3′ × 6″	1	145	78
3′ × 9″	1	147	79
3′ × 12″	1	170	91
3′ × 18″	2	176	95
3′ × 24″	2	147	79
3′ × 30″	2	186	100

4. The results of this experiment at Morogoro since it was begun are as follows:—

Distance of planting, in 3 ft. rows	Comparative yields						
	1923	1924	1925	1926	1927	1928	1929
6 inches apart ...	—	—	—	100	100	100	78
9 ,, ,, ...	100	100	44	—	100	96	79
12 ,, ,, ...	—	—	81	93	94	77	91
18 ,, ,, ...	78	70	100	75	99	82	95
24 ,, ,, ...	75	43	—	85	68	85	79
30 ,, ,, ...	—	—	—	84	64	63	100

The following facts must be noted before the results can be analysed:—

(a) In 1923, 1924 and 1925 the plants were thinned out to only one plant per hill.

(b) In 1926, 1927, 1928 and 1929 the plants were thinned out to one plant hill in the 6-, 9- and 12-inch spacings; but two plants were left in the 18-, 24- and 30-inch spacings.

(c) 1925 was an abnormally dry season.

(d) In 1929 germination was poor and the plots had to be supplied on 25th March. Even so the total stand was poor. The growing season was abnormally dry and yields were well below the average.

5. The unusually dry season experienced lends great interest to the 1929 results. There is an increasing yield from the narrowest to the to the widest spacing, except for one plot (24-inch spacing) which must have suffered from some cause not observed. The same general result will be found in the column for 1925, the other abnormally dry year in the series. The results in general point to the superiority of narrow spacing in normal years and of wide spacing in years of low rainfall.

6. *Cotton: Time of Sowing Experiment, 1929.*—In this experiment duplicate tenth-acre plots were planted at intervals of one week from 1st February to 22nd March. The planting distance was three feet by eighteen inches and two plants were left per hill. A summary of yields, together with the weekly rainfall figures for the period prior to planting, is given in the following table:—

Date of planting	Average plot yields: in lb.	Yield per acre in lb.	Comparative yields	Weekly Rainfall in millimetres
1.2.29	17·6	176	44	26·0
8.2.29	28·4	284	71	nil
15.2.29	29·0	290	72	11·6
22.2.29	31·5	315	79	nil
1.3.29	40·0	400	100	13·4
8.3.29	34·4	344	86	46·9
15.3.29	33·9	339	85	29·0
22.3.29	11·1	111	28	20·1
29.3.29	no planting	—	—	23·6

7. Below is given a summary of the results of this experiment since it was first carried out:—

Date of planting	Rainfall during Month in millimetres						Comparative yields					
	Month	1924	1925	1926	1927	1928	1929	1924	1925	1926	1927	1928	1929
February 1st ...	Feb.	261	118	46	4	57	25	—	—	—	67	—	44
,, 8th ...	—	—	—	—	—	—	—	100	100	—	—	99	71
,, 15th ...	—	—	—	—	—	—	—	—	—	—	83	100	72
,, 22nd ...	—	—	—	—	—	—	—	82	85	83	80	88	79
March 1st ...	March	153	43	196	187	77	131	—	—	94	79	59	100
,, 8th ...	—	—	—	—	—	—	—	26	62	100	100	47	86
,, 15th ...	—	—	—	—	—	—	—	—	—	91	—	7	85
,, 22nd ...	—	—	—	—	—	—	—	9	0	86	85	37	28
,, 29th ...	April	207	61	181	191	215	106	—	—	83	—	—	—

The result of the year's experiment again emphasises the desirability of planting as soon as possible after the beginning of the heavy rainy season.

8. *Cotton Variety Trials.*—The seven varieties included in the trial in 1928 were again used. All varieties were sown in triplicate tenth-acre plots on 9th March and were supplied sixteen days later owing to poor germination. All plots received similar treatment throughout the seasons. A summary of the results is given below:—

Variety	1929 yields per acre in lb. of seed cotton	Comparative yields				
		1925	1926	1927	1928	1929
Local (Uganda origin).	173	100	100	100	100	100
M. Selection	135	—	—	75	67	78
Foster X Whitehall ...	88	—	—	74	97	52
R. M. 68	95	—	78	61	87	55
N. 17	98	—	—	44	84	57
Rustenburg O. ...	78	—	—	40	79	45
Over the Top... ...	147	78	75	88	88	85

9. In all cases the seed used was produced on the station in 1928 in isolation plots. All plots suffered from the severe drought during the growing season and the yields per acre are therefore extremely low.

Even under such adverse conditions the local strain of Uganda seed gave the best results and continued its unbroken position at the head of the list.

10. *Maize Variety Trials.*—Quadruplicate plots of three varieties were planted on 14th March. The Potchefstroom Pearl, however, failed to germinate and was replanted on 20th March. Even so germination was poor and the plots of all varieties had to be supplied on 4th April. The results obtained together with the 1928 results, for comparison, are tabulated below:—

Variety	Yields per acre in lb.	
	1928	1929
Local Native	2,215	343
Potchefstroom Pearl	2,614	155
White Cango	2,422	413

11. The above results emphasise more than those obtained from any other crop the poorness of the season. What little information can be gained from them serves to confirm the drought-resisting qualities of White Cango and the native type as compared with Potchefstroom Pearl.

12. *Maize: Time of Sowing Experiment.*—This experiment was carried out with Potchefstroom Pearl seed in duplicate plots planted in rows spaced three feet by eighteen inches. The first two plantings on 26th January and 13th February failed to germinate. Different seed was therefore secured and on 28th March plots were again sown. Thereafter duplicate plots were sown at weekly intervals until 9th May. The results are given below:—

Date of Planting	Monthly Rainfall in mm. and number of days			Yield	
	Month	Rainfall	Days	lbs. per acre	Comparative
—	February	25·0	3	—	—
28th March 1929	March	130·8	20	92·7	100
4th April ,, ...	April	105·9	17	38·7	42
11th ,, ,, ...	—	—	—	3·7	4
18th ,, ,, ...	—	—	—	nil	nil
25th ,, ,, ...	—	—	—	nil	nil
2nd May ,, ...	May	36·6	12	nil	nil
9th ,, ,, ...	—	—	—	nil	nil

13. Previous results in this experiment are as follows: In 1926 the first planting was done in April and this gave the highest yield. In 1927, owing to lack of rainfall, the crop never matured. In 1928 the highest yields were given over a planting period of fourteen days, from 20th February to 5th March. This period coincided with the commencement of the main rains.

14. *Maize Spacing Trials.*—White Cango was the variety of maize used. Planting was carried out in duplicate tenth-acre plots on 14th March, and a few gaps were supplied on 4th April. The results obtained were as follows:—

Spacing	Yield per acre in lb.	Comparative yield
3′ × 12″	410	66
3′ × 18″	620	100
3′ × 24″	615	99
3′ × 30″	505	81
3′ × 36″	405	65
Native method	400	65

15. The comparative results since the experiment was begun at Morogoro are given below:—

Spacing	Yield per acre in lb.				Comparative yield			
	1926	1927	1928	1929	1926	1927	1928	1929
3′ × 6″	115	—	—	—	28	—	—	—
3′ × 12″	236	29	—	410	57	100	—	66
3′ × 18″	126	29	—	620	31	100	—	100
3′ × 24″	412	15	—	615	100	52	—	99
3′ × 30″	341	14	—	505	83	48	—	81
3′ × 36″	396	10	—	405	96	34	—	65
Native method	341	9	—	400	83	31	—	65
Broadcast at 15 lb. per acre	341	nil	—	—	83	nil	—	—

16. *Multiplication of Maize Seed.*—The results below are of interest as giving the yield per acre of two varieties of maize grown on the station under field, as opposed to experimental conditions. In a season when all yields were abnormally low the drought-resisting qualities of the White Cango variety were particularly apparent:—

Variety	Yield per acre in lb.
Potchefstroom Pearl	260
White Cango	718

17. *Sorghums: Spacing Experiment.*—In this experiment three tenth-acre plots were planted with the variety Bonganhilo and three with Kilinyali at each spacing. Planting was carried out on 28th January. Germination partially failed owing to the break in the rains and all plots were re-sown on 1st March. This sufficed for the Kilinyali variety but Bonganhilo again failed and a heavy re-sowing was made on 23rd March, which was partially successful. The results are given below:—

Spacing	Average yield per acre in lb.	
	Var. Bonganhilo	Var. Kilinyali
3′ × 6″	420	1,043
3′ × 12″	413	967
3′ × 18″	647	1,330
Native method	420	880

18. The following are the results from the commencement of this trial:—

Spacing	Average yield per acre in lb.			Comparative yield		
	1927	1928	1929	1927	1928	1929
3′ × 6″	1,391	2,226	731	100	100	74
3′ × 12″	1,353	2,132	690	97	96	69
3′ × 18″	972	2,053	988	69	92	100
Native method	1,006	1,808	650	72	81	66

19. *Sorghum Variety Trials: heavy yielding types.*—This experiment was divided into two parts. In the first, the varieties were planted in the normal planting season (that is, during the short rains) while in the second, planting did not take place until the main rains had commenced. Duplicate plots were planted in each section and gave the following results:—

Variety	Yield per acre in lb. planted on 7.1.29	Yield per acre in lb. planted on 1.3.29
Bonganhilo	665	423
Kilinyali*	385	522
Ngwana Kwimba	297	341
Sukesha*	297	352
Kihembahemba	242	330
Karachi*	33	nil

*Hard grained varieties.

In native farming, planting is carried out at approximately the time of the first sowing in this trial. Should the short rains fail, a second planting is carried out corresponding to that above.

20. The value of the experiment lies in the possibility of growing a quick-maturing crop (such as Tepary Beans) in the short rainy season, followed by sorghum in the heavy rains.

21. Results of trials with these sorghums since 1926 are given below, the date of planting in all cases being the normal one for native fields (in the short rains).

Variety	Yield per acre in lb.				Comparative yield			
	1926	1927	1928	1929	1926	1927	1928	1929
Bonganhilo	1,351	2,092	2,200	665	100	100	100	100
Kilinyali	1,074	1,287	1,848	385	80	62	84	58
Ngwana Kwimba	900	1,122	1,188	297	67	54	54	45
Sukesha	1,178	1,093	946	297	87	52	43	45
Kihembahemba	—	888	220	242	—	42	10	36
Karachi	260	209	154	33	19	1	7	5
Six other varieties discarded in 1928	—	—	—	—	—	—	—	—

22. The low yields obtained in 1929 were due to the drought. As Bonganhilo sorghum continues to be issued to native cultivators on an increasing scale it was gratifying to find in 1929 that this variety retained its superiority over all other types under the adverse conditions of the season.

23. *Sorghums: early maturing types.*—The following is quoted from the 1928 report on this trial:—

> "Dwarf sorghums have been imported and tried on this station since 1924 without success. The object of the importation has been to give an early source of food, if possible growing the crop during the short rains. Every attempt to grow these sorghums early in the season has resulted in failure. In seasons where the early rains have been scanty the sorghums have made such poor growth that the yields have been negligible; in seasons where the early rain has been adequate for growth, flowering and setting of seed has occurred at the opening of the heavy rains with the result that the heads have not set or have been so damaged by fungous diseases that no crop has been harvested."

The result of the 1929 trials bear out the above in full. Planting was done on 13th December, 1928, triplicate plots of each variety being sown. The yields obtained were as follows:—

Variety	Yield per acre in lb.
Bonganhilo	308
Red U.S.A.	114
Feterita	33
Dura	63
Dwarf Hegari	15

24. *Millet Variety Trials.*—The three quick-growing millets that have been under trial in previous seasons were again tested in 1929. Early plantings made in November 1928 and January 1929 were a complete failure and the experiment was begun again during March. Quadruplicate plots of each variety were sown on two occasions, twenty days being allowed to elapse between the plantings. The results obtained were as follows:—

Variety	Planted 8/3/29		Planted 27/3/29		Total average yield per acre in lb.
	Days to harvest	Yield per acre in lb.	Days to harvest	Yield per in lb.	
Poona Proso	75	615	66	970	792
Station Proso	75	714	66	1,024	869
Panicum frumentaceum	91	661	85	595	628

25. Previous results with this experiment are as follows:—

Variety	Yield per acre in lb.				Comparative yield			
	1926	1927	1928	1929	1926	1927	1928	1929
Poona Proso	192	147	422	792	47	33	83	91
Station Proso	343	62	463	869	84	14	92	100
Panicum frumentaceum	407	445	508	628	100	100	100	72

26. The fact that the highest yields were obtained in the dry season of 1929 may appear to be puzzling, but this is due to the late planting (in March, after the heavy rainy season had ceased) subsequent to the failures of two previous plantings, as compared with planting at an earlier season in previous years. The 1929 results are therefore of no comparative value with those of previous years. The value of these millets lies in the fact that they are more or less safe food crops in years of low rainfall, as the 1929 results have shown.

27. *Millets: Distance of Sowing Experiment.*—In this trial triplicate plots of each spacing were sown on 18th March. Seed of the Poona strain of proso millet (*Panicum miliaceum*) was used. The following were the results:—

Spacing	Yield per acre in lb.
Broadcast at 15 lb. per acre ...	1,272
,, ,, 25 lb. ,, ,, ...	1,457
Sown in drills 6" apart ...	1,397
,, ,, ,, 12" ,, ...	1,562
,, ,, ,, 24" ,, ...	1,468
,, ,, ,, 36" ,, ...	973

28. Comparative results with previous seasons are as follows:—

Spacing	Yield per acre in lb.			Order of yield		
	1927	1928	1929	1927	1928	1929
Broadcast at 15 lb. per acre ...	1,281	814	1,272	2	2	5
,, ,, 25 lb. ,, ,, ...	935	671	1,457	6	5	3
Sown in drills 6" apart ...	1,380	814	1,397	1	2	4
,, ,, ,, 12" ,, ...	1,199	902	1,562	3	1	1
,, ,, ,, 24" ,, ...	951	781	1,468	5	4	2
,, ,, ,, 36" ,, ...	1,012	367	973	4	6	6

In 1927 planting was done on 10th December, 1926; in 1928 on 21st February, and in 1929 on 18th March. In the first trial, therefore, the millets were planted as a short rain crop and in the succeeding years as crops for the big rains. The results show no great advantage of drilling over broadcasting.

29. *Multiplication of Seed.*—While the primary function of this station is crop experimentation, an important secondary function is the multiplication of seed for distribution. Seed is supplied from the station to the tribal farms or sub-stations in the district, to natives and non-natives and to other Agricultural Stations throughout the Territory. A schedule in Part I of this Report shows the distribution of planting material during the year.

30. *Investigations with Plants.*—Plants of varying economic importance were raised in the nurseries of the station. The propagation of fruit trees and ornamentals for distribution throughout the Territory was continued. The demand for such planting material is increasing yearly. Planting of small sections of trees of either economic or botanic interest in the arboretum is progressing as seedlings become available. Plant and seed introductions other than those dealt with in the annual crop experiments are shown in the following table:—

Quantity introduced					Number of species represented
Plants	Seed Packets	Cuttings	Rhizomes	Suckers	
160	15	1 bundle	5 lb.	66	28

The following are the results of trials with some of the more important plants during the year:—

Aleurites triloba, Candle-nut. Twelve seedlings planted in the arboretum during April 1928, have made very satisfactory growth, and now average from twelve to fifteen inches in height. One of the trees has just commenced flowering, at two-and-a-half years after planting. This species is undoubtedly well suited to local conditions.

Hydnocarpus Wightiana. Three plants (seedlings originally received from Kew Gardens) have been established and are growing well; the average height is five inches, age about two-and-a-half years.

Hydnocarpus anthelmintica. Thirty-seven plants have now been established. The height is from three to five inches, age two to two-and-a-half years.

Sterculia diversifolia, Kurrajong. Six plants have been established, but have grown very little during the past year, producing practically no foliage. The leaves are most diverse in character; six different types of leaves have been already observed.

Ceratonia Siliqua, Carob or Locust bean. It is intended to established six plants, but difficulty has been experienced in transplanting the seedlings, and so far only three have rooted successfully.

Citrus. Of the ten varieties introduced from South Africa, only Marshs' Seedless grapefruit and Bitter Seville orange have shown satisfactory growth during the past season. Three varieties have died. Most of the plants arrived in very poor condition. The remainder are alive, but dormant.

Coffea robusta. Approximately seventy seedlings of this species of coffee raised from seed obtained from Amani have been planted out.

Phytolacca dioica. Bella Sombra. Six plants have been established in the arboretum. The species is a fairly rapid grower and appears to be thriving well under local conditions.

C. B. Garnett,
District Agricultural Officer.

MPANGANYA AGRICULTURAL STATION, RUFIJI DISTRICT

The average rainfall of the station over eight years of records is 862 millimetres. 1929 was the driest year of the eight, the precipitation being 643 millimetres, and it succeeded the second driest year, 1928, when the precipitation was 651 millimetres. The following is the monthly rainfall for the station for 1929, in millimetres, together with the averages over eight years:—

Month	1929	Average of eight years
January	129·5	132·9
February	30·5	70·8
March	96·9	170·9
April	192·8	248·9
May	25·9	56·6
June	10·2	0·7
July	10·8	3·1
August	0·6	5·9
September	9·5	12·4
October	8·8	24·8
November	46·7	65·4
December	80·8	69·6
TOTAL ...	643·0 mm. or 25·7 inches	861·9 mm. or 34·4 inches

2. *Cotton: Time of Sowing.*—This experiment, as in previous years, was carried out in duplicate one-fortieth acre plots in both section A of the station, representing the light unflooded higher lands of the Rufiji valley, and in section B, representing the deep silt soils of the valley lowlands which are liable to be flooded by the annual rise of the river. The results are given in the following table:—

Plot No.	Date of Sowing	Monthly Rainfall mm	Section A		Station B	
			Per cent. Stand	Comparative yield	Per cent. Stand	Comparative yield
1	8.1.29	January 129·5	94	50	83	86
2	22.1.29	February 30·5	77	100	63	100
3	5.2.29	March 96·9	33	61	32	50
4	19.2.29	April 192·8	20	69	40	94
5	5.3.29	May 25·9	60	84	76	73
6	19.3.39	June 10·2	90	58	97	70
7	2.4.29	July 10·8	89	69	96	50
8	16.4.29	August 0·6	54	65	40	45
9	30.4.29	September 9·5	66	42	100	23
10	14.5.29	October 8·8	96	39	85	19

In the experiment no resowings are made, but the comparisons of the recorded percentage stands of the various plots indicate the increase which might be attained by resowing the gaps in the normal manner.

3. Comparison of the results with previous years is as follows:—

Year	Optimum Date of Sowing		Yield per acre of seed-cotton	
	Section A	Section B	Section A	Section B
			lb.	lb.
1925	3rd March ...	—	1,136	—
1926	5th February ...	8th January ...	812	1,420
1927	22nd January ...	22nd January ...	692	1,050
1928	9th January ...	2nd April	422	360
1929	22nd January ...	22nd January ...	260	884

These yields per acre are interesting in that they indicate the unfavourability of the later seasons to the cotton crop, which should be taken into account when the progress of cotton growing in any one area is considered.

4. The results of the experiment of the present season are very similar, in the individual plot yields of the same times of sowing, as for the year 1928, except that the later sown plots have given greater comparative yields in this season than last, due to the heavy rains which fell in April: the total rainfalls over the growing periods are practically identical for both years. The importance of early sowing is again clearly indicated, and the time of sowing experiments over eight years at Mpanganya have been the means of correcting, by the publication of the results to non-natives and by actual demonstration to natives, the idea that cotton should be planted in April, the month of greatest rainfall, whereas it should be so planted that the plants are in flower during the period of greatest rainfall; and if prospective cotton growers remember that cotton normally requires sixty days from the time of germination to the time of flowering, then a study of the meteorological records, now widely available, will give a fairly accurate indication of the best time to sow cotton.

5. *Cotton: Spacing.*—The spacing experiment consists of a series of six plots sown in duplicate at different spacings in both sections A and B, each plot being one-forteith acre in area. The results of the experimentation for each section, since the year 1926, are given in the following tables:—

Plot No.	Spacing	Comparative yields for Section A				Comparison of averages of four years
		1926	1927	1928	1929	
1	3′ × 6″	60	66	100	100	95
2	3′ × 9″	50	65	92	92	88
3	3′ × 12″	55	100	80	92	96
4	3′ × 18″	85	58	94	88	95
5	3′ × 24″	100	65	90	85	100
6	3′ × 30″	72	63	82	60	70

Plot No.	Spacing	Comparative yields for Section B				Comparison of averages of four years
		1926	1927	1928	1929	
1	3′ × 6″	98	30	94	96	84
2	3′ × 9″	91	57	97	94	90
3	3′ × 12″	90	84	92	97	96
4	3′ × 18″	88	94	100	94	100
5	3′ × 24″	67	100	97	100	96
6	3′ × 30″	59	54	84	85	75

6. Statistical work so far carried out at the Mpanganya Agricultural Station indicates that the probable error of experimentation for the cotton crop on the sandy soils of section A is four per cent. of the crop; while with the more uniform silt soils of section B, it is but three per cent.; and before any reliability can be placed on the results of experimentation, the difference per cent. between any two plots must be at least twice the probable error of the series of plots. Thus no conclusive significance can be attached to the above results, although there are indications that the closer spacings give the best results on the drier sandy soils of section A, especially with such reasons of poor rainfall as in 1928 and 1929; also that better results are obtained by slightly wider spacing on the heavier soils of high moisture-content of section B.

7. *Cotton: Ratooning.*—The results of the ratooning experiment, over the four years in which it has been carried out, are as follows:—

Year	Yield per acre of seed-cotton	
	Ratooned Cotton	Ordinary Cotton
	lb.	lb.
1926	433	733
1927	29	485
1928	10	183
1929	45	260

The main reason for the failure of the ratooned cotton is the small percentage of plants which survive the hot dry period intervening between the short and the long rains. From the yield point of view alone, the above results conclusively prove the unsuitability of ratooning cotton in the coastal areas; on the cultural side there is no saving, as two or three careful cultivations are required costing practically as much as the preliminary digging required for the normal planting of cotton. The plants produced by ratooning are not of the desired single stalk type, and the branches sweep the ground, resulting in very dirty seed-cotton. The value of the lint has been placed by Liverpool brokers at twenty-three per cent. lower than the ordinary cotton. Insect attack is two to four times greater than with ordinary cotton, which, together with the conclusiveness of the results obtained, is sufficient cause to discontinue the experiment at Mpanganya.

8. In addition to the ordinary ratooning experiment, described above, and in which the plants are cut down at the usual time of the compulsory uprooting and burning measures, and then allowed to grow again without further disturbance, a second series of ratooned plots were carried out in which the plants were kept cut back until the usual time of sowing cotton in early February. This continued pruning was too severe for the plants over two practically rainless months, and less than three per cent. survived.

9. *Cotton Variety Trials and Cotton Selections.*—The seed of all cotton varieties under trial, together with all the Mp selections and the J cotton, were handed over to the Cotton Investigator, Mpanganya, for his work in the present season, and they will be dealt with in his report, immediately following this report.

10. *Relation of Cotton to other Crops.*—The work of the Mpanganya Agricultural Station regarding the interplanting of cotton in other crops has been summarised in an article prepared for publication in the *Empire Cotton Growing Review*, as follows:—

> "Experiments have been carried out at Mpanganya to obtain comparative data of cash returns of rice sown as a pure crop, and rice intersown with cotton. The former gave 1,639 lb. of paddy at a gross return of Shs. 149/- per acre, while where cotton was planted in between the lines of flowering rice, the yields were 1,298 lb. of rice and 597 lb. of seed-cotton, the total return from the rice and cotton crop being Shs. 163/- per acre. There is also the value of the cover-effect of the cotton crop, which by leaving the land clean at the end of the season appreciably reduces the labour costs for the preparation of the land in the following year.
>
> "It is still difficult to persuade natives to plant cotton in the Rufiji District; but it has been found the easier to do so where a system of interplanting with other crops is encouraged. For this the maxim is taken that shaded cotton is no cotton; and keeping the characteristics

of the various grain and pulse crops in mind, successful combinations have been worked out at the Mpanganya Station, giving yields of cotton little below those obtained from pure crops, together with yields of grain superior to the yields from such crops grown in native fashion, not lined-out and wasteful of land and labour. The method attains two objects, namely the lining-out and correct spacing of food and other crops, which results in increased yields, and the extension of the cotton crop. After that of cotton with rice, the most important combination is the planting of cotton between the lines of *ripening* maize spaced at three feet by eighteen inches; a month or so after sowing the cotton, the maize is harvested, the stalks of which are cut out and used as an effective mulch for the succeeding cotton.

"With gram and Tepary bean, cotton can be sown either at the same time or after the pulse crop. The tall coarse-growing native sorghums are not suitable; but cotton can be intersown with the short finer introduced types, such as Dwarf Hegari and Feterita, introduced from the Sudan. Good results are also obtained by planting cassava slips between the lines of cotton at any period of its growth."

11. During the present season, cotton was intersown in the maize crop of the lowlands section B, which yielded 1,667 lb. of grain per acre. The maize was sown on 13th February and was harvested on 11th June. The cotton was intersown on 10th April and gave a yield of 470 lb. of seed-cotton per acre, under the worst conditions of rainfall experienced for many years. At the end of November, after the cotton was uprooted and burnt, the field was perfectly clean and required comparatively little labour to prepare the land for the succeeding rice crop.

12. *Rice Variety Trials.* The nomenclature of the various rice types is both misleading and confusing. The varieties to which an abundant supply of water is essential are known as "lowland" or "marsh-land" types, but there are many typical lowland areas which are unsuitable to the water-loving rice varieties, and "marsh-land" leads one to think of undrained swampy land which is also mostly unsuitable. As far as this Territory is concerned, it is considered that the types should be grouped as follows:—

(a) *Hill-land rice*, consisting of that comparatively small group of varieties which will grow on hill-sides. Their success under such conditions is dependent on rainfall, and they have a deep root-system to enable them to take full advantage of the soil moisture and to withstand rainless periods, which in the hills are usually shorter than on plains and plateaus. The hill-land varieties are all quick maturing.

(b) *"Wet-land" rice*, to which an abundant supply of water is essential a month before and during the flowering period. This water may be artificially supplied by irrigation, a rare proceeding in Tanganyika, or by a natural flooding by large river systems, such as occurs during March to April in the lowlands of the

Rufiji valley, and also by the equinox tides which cause flooding of small areas adjoining coastal streams, and allow two crops of rice to be taken per year. This group is the second largest. The varieties have a very shallow root system, so that in the event of the failure of the annual floods, the plants are unable to stand the dry conditions and crop failure results. The "wet-land" rices are longest maturing, and give the greatest yields when the conditions are suitable, but except where irrigation is practised these types should be regarded as the more risky kinds to grow.

(c) "*Dry-land*" *rice*, which can be grown without a supply of water supplementary to the rainfall, provided that the soil is a deep silt or fertile loam, having a high moisture retentive capacity, which enables the plant to receive the full benefit of the rainfall. It is obvious that a good surface cultivation is necessary to provide a protective mulch during the growing period of the crop. Close spacing is also beneficial in that the crop itself provides protection from soil evaporation by its shade. The group is not suited to hill-lands or to porous soils. It has a root system better than that of the lowland group but not so deep as that of the hill-land types, and this enables the varieties to withstand dry periods over an amazingly long time if dry farming methods are followed. The dry-land group contains by far the greatest number of varieties.

13. All hill-land varieties can be grown under so-called dry-land conditions, but only the strong-strawed hill-land and dry-land varieties can be grown under wet-land conditions, and it is these comparatively deep-rooted varieties which give the greatest average yields over a number of years. Being comparatively sure croppers the cultivation of these should be encouraged at the expense of the more risky wet-land types.

14. The number of rice varieties indigenous to the Rufiji District, included in the experimental trials in the present season, were thirty-one, an increase of seven over the previous year, and in addition there were Pa D.C. introduced from Sierra Leone in 1927, and Sena from Mwanza. The varieties were sown on 5th January, in duplicate plots of triple lines ninety feet long, at a spacing of eighteen inches by nine inches, thinning to one plant per hill being made when the plants were six inches in height. The yields were obtained as an average of one hundred plants of the middle of the centre row of each plot, so that the comparative results given in the following table should be an accurate measure of the merits of the different varieties; the order of merit for previous years is also given:—

Variety	Comparative Yield	Order of Yield			
		1929	1928	1927	1926
Mwanga (D)	100	I	II	XVII	XII
Ndondo (D)	100	I	—	—	—
Komamanga (D) ...	91	III	IX	VI	VI
Mwache Apande (D)...	88	IV	—	—	—
Meno Meupe (D) ...	82	V	VI	XI	I
Afiri (D)	73	VI	I	III	VII
Ngukuru (H)	68	VII	XIV	—	—
Ngowe (D)	65	VIII	VI	VII	IV
Unyengwa (H)	63	IX	XIV	XVIII	XIII
Kichawachawa (D) ...	63	IX	XII	XIII	IX
Almeri Mgeni (D) ...	63	IX	XII	XI	VIII
Borakupata (H) ...	63	IX	XVIII	—	—
Rusukwi (D)	55	XIII	—	—	—
Hebu (D)	50	XIV	V	XXI	XVI
Bilgili (D)	50	XIV	XIX	—	—
Marula (D)	42	XVI	IV	XV	III
Jegerenati (D)	42	XVI	XX	III	XI
Binti Karibu (D) ...	42	XVI	—	—	—
Bungala (D)	38	XIX	III	XIV	—
Kilimali (W)	27	XX	XIII	IX	V
Mtambara (W)	27	XX	—	—	—
Kilowae (W)	20	XXII	X	XX	X
Kanunge (W)	20	XXII	XIV	II	—
Maridadi (W)	20	XXII	XXI	I	—
Pa D.C. (W)	20	XXII	XVII	—	—
Mpemba (W)	17	XXVI	XXIII	XIX	XIV
Stima (W)	12	XXVII	XXII	V	—
Afa (W)	12	XXVII	XXV	IX	XVII
Mkweke (W)	10	XXIX	—	—	—
Sena (W)	10	XXIX	—	—	—
Korongo (W)	0	XXXI	—	—	—
Msamaki (W)	0	XXXI	XXIV	XV	—
Kimoto (W)	0	XXXI	XXVI	XXII	XV

NOTE. H = Hill-land type. W = Wet-land type. D = Dry-land type.

15. The above results should be examined with respect to the rainfalls of the different years, which were, in millimetres, 746 for the year 1926, 1,120 for 1927, 651 for 1928 and 643 for 1929. It will be seen that the dry-land rices take the highest places for the years of poorer rainfall, while even in the year 1927, of extremely heavy rainfall, when the plots were submerged in several inches of water, there were several dry-land types yielding more heavily than some wet-land varieties; furthermore the disparity in yields in 1927 was not wide as in the present dry season, whereas the wet-land rices were a complete failure in the present season, and extremely poor in 1928. There is a reflex of this in the native grown rice crop of the Rufiji, which in 1928 produced 2,500 tons of paddy for export, due to the fact that although the rainfall was poor the conditions of river flooding were ideal over a wide area, whereas in 1929 with its poor rainfall and failure of flooding, less than 150 tons were exported.

This, together with the food shortage suffered by the natives, indicates the need of some method of inducing the native to accept the results of this experimentation. The main rice crop of Unyengwa (hill-land) has never been less than 1,000 kilograms per acre and has been as high as 1,800 kilograms.

16. It has been difficult in past years to confirm the native growers' classification of rice varieties as dry-land or wet-land types, but the behaviour of the varieties under trial in the present season of extremely poor rainfall leaves no room for doubt, and the varieties Kilimali, Kilowae and Maridadi, previously regarded as dry-land types, are now classed in the wet-land group.

17. The variety Unyengwa, which is highly regarded as having the qualities most likely to effect a wide improvement in rice cultivation for export, has taken a better position in the trials than in the past, and shows the need of a period of acclimatisation where rice varieties are brought to entirely new conditions, in this case from the hills to the valley. Further, the conditions of trial, whereby the plants are grown singly, handicap this variety, its growth being in spreading form when grown as a single plant, but when grown in bunches of three or more plants, as occurs in the field, it tends to an erect form, and under these conditions its yield invariably surpasses that of all other kinds, and is most outstanding in years of poor rainfall.

18. With all the varieties under trial, observations were taken of the botanical characteristics of the plant; these should in time provide useful information for a monograph on the rices of the Territory. It may be mentioned here that the two main groups of rice, *Oryza sativa* and *Oryza glutinosa*, are easily distinguished by the iodine test (in which the grains are cut in two and dipped in a weak solution of iodine); with the former starchy group the section stains dark violet, with the retrogressive glutinosa rices, the section stains brown. This test classified all the above varieties as *Oryza sativa*.

19. *Rice Improvement by selection.*—The necessity and means of rice improvement was explained in the report of this station for the year 1928. The importance of this work has been accentuated by the wide failure of the native rice crop in the present year. The broad lines followed in the work of plant selection are re-stated as follows:—

(a) To produce a type as independent as possible of water supply, by selection from dry-land and hill-land types whose outstanding quality, in addition to yield and early maturity, must be a strong erect straw to enable the plant to stand up to heavy rainfall or irrigation; that is, to produce a dry-land or hill-land type which will do well under wet-land conditions capable at the same time of yielding a crop when these river lands receive little or no flooding.

(b) To select any plants from the wet-land group, which, in addition to heavy yield and good quality of grain, shows exceptional resistance to dry periods, that is, to produce from these a dry-land type which will naturally have a strong straw.

20. The work of selection has now reached the first generation, the results obtained are most encouraging; these are given in the following table as yields per 100 plants, together with the yields of the ordinary parent types, to give a measure of comparison:—

Selection No.	Parent Type	Yield per 100 Plants	
		Selection	Ordinary
		lb.	lb.
1/28	Hebu	6·5	3·0
10/28	Almeri Mgeni	15·0	4·0
20/28	Komamanga	9·0	5·5
30/28	Unyengwa	12·2	4·0
40/28	Bungala	12·0	2·3
50/28	Mwanga	8·0	6·2
60/28	Pa D. C.	10·3	1·2
70/28	Borakupata	8·5	4·0

21. From the above selections, the following are to be multiplied for seed purposes:—

No. 10/28 Almeri Mgeni
No. 20/28 Komamanga
No. 50/28 Mwanga
No. 60/28 Pa D.C.

22. In addition, re-selections of single outstanding plants have been made as follows:—

No. 21/2/28 from No. 20/28 Komamanga
No. 31/2/28 from No. 30/28 Unyengwa
No. 32/2/28 from No. 30/28 Unyengwa
No. 33/2/28 from No. 30/28 Unyengwa
No. 61/1/28 from No. 60/28 Pa D.C.
No. 62/2/28 from No. 60/28 Pa D.C.

Re-selections from the first generation of a single selected plant amount to single seed selections and the above re-selections are thus pure lines. Selections Nos. 1/28, 40/28, and 70/28 were discarded.

23. The selection of Unyengwa No. 30/28 was made on the lines of paragraph 19 (a), and as stated in paragraph 17 the weakness of this variety lies in its spreading habit and spindly straw, tending to lodging when grown under conditions promoting luxuriant growth. The selected plant was outstanding in being erect and thick-strawed. Its progeny contained both spreading and erect types, and it was from the latter that the re-selections Nos. 31/2/28 to 33/2/28 were made, and to these that the utmost importance is attached.

24. The selection of Pa D.C. No. 60/28 (a rice of good quality and most attractive appearance), was made on the lines of paragraph 19 (b). The extremely dry season was a severe test for this method of working from a wet-land to a dry-land type; the drought resistance of the selection is shown in its yield which is almost eight times that of the parent type.

25. *Bulrush Millets.*—Local types of bulrush millets were sown in January at a spacing of three feet by eighteen inches, in trial with the bolder-grained types from Tabora and Dodoma. The results, together with the order of yield for this and previous years, are given in the following table:—

Variety	Yield per 100 Plants	Order of Yield		
		1929	1928	1927
	lb.			
Tabora	21.9	IV	I	—
Dodoma	34.0	I	III	VIII
Lumbururu	16.5	VII	VII	VII
Kisogo	20.0	V	V	I
Kukwili	22.0	III	VI	V
Nyamihuki	15.6	IX	IV	IV
Ruhonyo	15.9	VIII	IX	VI
Nyamatoti	17.9	VI	VIII	III
Mkula	28.3	II	II	II

26. The Dodoma variety is best suited to seasons of poor rainfall, such as the years of 1928 and 1929. It has a large thick head which does not dry readily after rain, and so suffers badly in wet-seasons from moulds and a considerable loss of grain results, as is seen from its low position in the table in the abnormally wet year of 1927. Also, after three seasons on the coast it has lost its initial superiority of boldness of grain. The Tabora variety has the advantage of being of earlier maturity than the local types. It would appear that the local variety Mkula, which has been consistently high in yield whatever the season, offers the best opportunity for improving the coastal crop. This can be done in detail by selection.

27. *Sorghum Millets: Local Types.*—It is believed to be unlikely that introduced types will effect an immediate marked crop improvement, owing to possible wide differences in climatic and other conditions. It is more likely that an examination of the indigenous types, which, through generations of cultivation have become suited to local conditions, will more likely bring to light a little known variety which has a marked yielding capacity, even under difficult conditions (such as the hill-land Unyengwa rice and the bulrush millet Mkula). The native cultivator is non-progressive and has little knowledge of his crop kinds, and is mostly ruled by conservatism in his choice of varieties, so that comparative trials of the indigenous crop varieties are also essential as a basis for advice to the native.

28. The Sorghum millet crop has now been added to the list of crops under trial at Mpanganya for the examination of local kinds, and in the present season ten varieties were grown, including three, Bonganhilo, Sukesha and Kilinyali, from inland districts. The plots were sown on 31st January, in duplicate, in triple lines spaced at three feet by eighteen inches. The comparative yields, given below, were obtained from the average of 100 plants taken from the centre rows.

Variety	No. of days to flowering	No. of days to harvest	Comparative Yield
Kanga	91	144	100
Nokore	91	144	99
Mbangara	93	144	92
Kibwe	93	144	89
Ndunyungu	91	144	67
Jebere	91	144	64
Sukesha	87	144	46
Kilinyali...	91	144	42
Bonganhilo	91	157	9
Karachi	113	166	nil

29. The long maturing Karachi variety was exposed to a greater period of drought than the other types and its yield was negligible. Of the three varieties from inland Sukesha was the best, and its early maturity and good quality of grain has led to a demand for seed by natives. It is interesting to note, especially with Kilinyali, that the quality of the grain deteriorates in the more humid coastal areas, and becomes larger and softer than when grown inland. The Bonganhilo variety is far too soft for this district, and the seed quickly loses its powers of germination, its compact rigid head becomes mouldy in the field and a poor quality of grain is produced.

30. *Sorghum millets: Introduced varieties.*—Unfortunately, the desirable quality of hardness of grain found with most indigenous sorghums, is absent from the introduced varieties, which however are much earlier maturing, and are mostly resistant to smut, although they are more susceptible to rust than the local kinds. The results of the trials of the three varieties, two of which have shown promise in previous years are as follows:—

Variety	No. of days to flowering	No. of days to harvest	Yield per acre lb.
Red Leoti	57	81	80
Feterita	42	81	120
Dwarf Hegari	37	100	480

The plots were all sown at a spacing of three feet by eighteen inches, but the plants would stand a closer spacing of eighteen by nine inches, with corresponding greater yields. It is essential that these varieties be sown late enough to allow ripening to take place after the end of the rains, otherwise, if the heads mature during the rains, moulds are produced and the yield of grain is low. The varieties have gained the

interest of sisal growers as a possible alternative to interplanting maize in sisal, the maize crop being too dependent on rainfall and erratic in yield.

31. *Maize.*—The maize trials included Kenya Hybrid, Potchefstroom Pearl, White Cango and Argentine varieties, but, for the second consecutive year, the trials were rendered valueless by damage from elephant, buffalo and hippopotamus. In the past years of trial, Kenya Hybrid maize has proved by far the heaviest yielder, but it is unpopular with the native growers owing to its long maturing period. Natives prefer the early-maturing white flint type and will readily plant such a variety as White Cango. With this or a similar variety it is possible to achieve a wide improvement in the native maize crop, which so far has been impossible with the Kenya Hybrid type.

32. *Beans.*—Three introduced and two local kinds were included in the trials, the results of which are given below:—

Variety	No. of days to harvest	Yield per acre lb.
Lima Abundance	130	480
Canandian Wonder	—	nil
Tepary Bean	90	90
Bonavist Bean	130	270
Cowpeas	100	216

Bonavist bean is the local Fiwi, which if sown early in January, forms an excellent cover crop lasting until late July, although the yield of grain is less than when sown in March. On good lowland soil Tepary bean yielded at the rate of 1,150 lb. per acre.

33. *Miscellaneous Crops: Proso millet.*—This was sown on 3rd March at a spacing of three feet by eighteen inches, and was harvested three months later, giving a yield of 520 lb. of grain per acre. The height of the plants at harvest was one foot eight inches. It could be sown with advantage at the close spacing of eighteen inches by nine inches. It would appear to be a promising drought resistant crop, which after further trial and demonstration could well be introduced into native agriculture.

Panicum frumentaceum.—This was sown on poor sandy soil at a spacing of eighteen inches by nine inches on 13th March, and was harvested three months later, giving a yield, despite the poor conditions of soil and rainfall, of 400 lb. of grain per acre. This should also be a valuable drought-resisting crop to the native: it is also stated to be well suited to lowland areas to prevent soil washing. There should be a suitable market for this grain as chick food.

Chick Pea.—This was sown on 25th January, again on 20th March and 4th April, but in each case, despite good initial growth, the plants were unable to produce seed, and it is evident that this crop is entirely unsuited to the low coastal conditions.

Groundnuts. - The varieties Virginia Bunch and Basse were grown for comparison with the native types, but owing to the drought the yields were negligible.

Passiflora foetida. This is a drought-resisting cover crop suited to all classes of soil, which for a second year proved its great value in effectively smothering all weeds and preventing soil washing. It will remain on the land for two years and possibly more on the heavier soils. It is advisable to soak the seed well in water before sowing, as it has a hard gelatinous protective coat, or the ripe fruits may be planted to give rapid germination.

34. *Seed Multiplication.*—The following amounts of selected seed were harvested for distribution to natives and to other districts:—

	Kgs.
Bonavist bean	356
Tabora bulrush millet...	93
Dodoma „ „	86
Kilinyali sorghum	328
Bonganhilo „	127
Sukesha „	179
Panicum frumentaceum	393
Green gram	699
Unyengwa rice...	1,512
Tepary beans	263
Cowpeas	127
Kenya Hybrid maize	1,527
White Cango maize	328
Dwarf Hegari sorghum	52

1,456 kilograms of seed-cotton from the experimental plots was sold to Kilimani Ginnery.

A. J. Wakefield,
District Agricultural Officer

COTTON INVESTIGATION AT THE MPANGANYA AGRICULTURAL STATION.

COTTON VARIETY TRIALS.—As the quantity of seed available did not permit of a proper yield trial in consecutive triple rows being carried out, the varieties were planted in one-fortieth acre plots on section A. The main object being the maintenance of pure seed stocks, the plots were situated seventy yards apart. At the same time comparative yields per plant were obtained and other observations made, details of which will be found in subsequent paragraphs. The seed of the Haiti cotton arrived too late to be planted in time for a proper comparison, but was planted in a similar manner to the other varieties but on section B. It only yielded a few pounds of poor badly stained seed cotton. The seed of *Gossypium herbaceum* was not sufficient to plant a one-fortieth acre plot and was planted in two lines eleven yards long; only two seedlings survived to produce flowers, but no bolls were matured, all dropping off in the early stages of development.

2. Yields of the varieties are given in tabular form below, ordinary district cotton being included for comparative purposes:—

Variety	Yield per plant in grams	Order of yield
Webber 49	Nil	—
Webber	17·73	9
Early King (King 29) ...	34·71	3
R M 53	17·86	8
R M 68	33·85	5
R M 90	27·05	6
Improved Bancroft ...	37·45	1
Griffin	10·13	10
Uganda	8·92	11
Watt's Long Staple ...	23·20	7
Uganda 17	36·90	2
Rustenburg O	8·87	12
Foster X Whitehall ...	6·70	13
Ordinary District	34·58	4

3. THE MP. SELECTIONS.—The Mp. selections with district cotton as check, were planted similarly to the cotton varieties in one-fortieth acre plots bordering section B of the Experimental Station:—

Plot No.	Selection	Yield per plant in grams
1	Ordinary District	19·4 (VIII)
2	Mp 9	61·5 (III)
3	Mp 19	36·3 (V)
3	Mp 8 1	22·0 (VII)
5	Mp 9 2	30·0 (VI)
6	Mp 4 2	72·9 (II)
7	Mp 12	56·2 (IV)
8	Mp 13 3	83·6 (I)

4. None of the selections showed outstanding yielding qualities although individual plants were exceptional. The best of them were superior in this quality to those of the varieties on trial.

5. OBSERVATIONS ON THE VARIETIES AND SELECTIONS.—Observations were made under the following heads:—

(a) Maturity.
(b) Resistance to drought.
(c) Resistance to insects, particularly Jassid.
(d) Resistance to diseases.
(e) Growth and habit.

(a) *Maturity.*—

Variety or Selection	First flowers	Flowering General	First flushing	Order of maturity: complete pickings
Webber	May 14th	June 6th	August 5th	9
Early King	,, 6th	,, 4th	July 20th	8
R M 53	,, 9th	,, 4th	,, 2nd	2
R M 68	,, 6th	May 26th	,, 2nd	1
R M 90	,, 10th	June 6th	,, 20th	12
Improved Bancroft ...	,, 8th	May 28th	,, 2nd	5
Griffin	,, 9th	June 5th	,, 20th	11
Uganda	,, 8th	May 28th	,, 2nd	6
Watt's Long Staple ...	,, 6th	,, 28th	,, 2nd	4
Uganda 17	,, 5th	,, 25th	,, 11th	13
Rustenburg O	,, 10th	,, 30th	,, 29th	14
Foster X Whitehall ...	,, 21st	June 11th	,, 29th	19
*Ordinary District A ...	,, 12th	May 30th	,, 20th	15
*Ordinary District B ...	,, 9th	,, 27th	,, 11th	10
Mp 9	,, 9th	June 4th	,, 3rd	16
Mp 19	,, 6th	May 26th	,, 3rd	7
Mp 8 1	,, 6th	,, 26th	,, 3rd	3
Mp 9 2	,, 6th	,, 27th	,, 3rd	9
Mp 4 2	,, 17th	June 4th	,, 11th	14
Mp 12	,, 21st	,, 4th	,, 20th	17
Mp 13 3	,, 20th	,, 4th	,, 20th	18

*Ordinary District is Uganda Upland cotton grown in the district for some years.

The following varieties and selections in their order of sequence may be regarded as early: RM 68, RM 53, Mp 8/1, Watt's Long Staple, Improved Bancroft, Uganda, Mp 19, Early King and Mp 9/2. The following may be classed as late: Mp 9, Mp 12, Mp 13/3, Foster X Whitehall, Rustenburg O, and Webber. With the last three only one picking was obtained and no more cotton was produced. The remaining varieties and selections approximate closely to the behaviour of the ordinary district cotton. Early King was rather slow in opening its first bolls but

later ripened up in a very short space of time. The earliest maturing varieties ripened rapidly and were almost denuded of cotton at a time when the ordinary district cotton was still green and fruiting.

(b) *Resistance to Drought.*—As the season was exceptionally dry, considerable information was got with regard to the drought-resisting qualities of the various varieties. The following were decidedly drought-resistant: —Mp 9, Mp 13/3, Uganda 17, RM 53 and Early King. Those resistant but not markedly so were: RM 90, Ordinary District, Mp 9/2 and Improved Bancroft. Those which suffered considerably were: — RM 68, Watt's Long Staple, Foster X Whitehall, Mp 4/2, Mp 8/1 and Mp 19. Those which suffered severely were: —Griffin, Uganda Upland, Rustenburg O, and Webber.

(c) and (d) *Resistance to Insects and Disease.*—Details will be found under the headings Entomological and Mycological.

(e) *Growth and Habit.*—The following varieties and selections showed vigorous growth and a tendency to the over-production of vegetative branches: —Improved Bancroft, Uganda 17, Mp 12, Mp 9 and Mp 4/2. The following produced good open plants with a minimum of vegetative branches: —RM 53, RM 90, Mp 9/2, Mp 13/3, Uganda and Watt's Long Staple; the last two rather lacked in vigour; Mp 13/3 was backward in the early stages of growth but later showed great vigour. The remaining varieties were of brushy, straggling type.

6. LENGTH OF STAPLE.—The cotton varieties and selections on being examined in the laboratory for maximum staple length (a mean of seven measurements for each sample being taken) gave the following results: —

1 3/16 ins.	Mp 9, Mp 4/2, Mp 12, Mp 9/2.
1 2/16 ins.	RM 53, RM 68, RM 90, Uganda 17, Mp 19, Mp 8/1, Mp 13/3, Ordinary District.
1 1/16 ins.	Griffin. Uganda, Foster X Whitehall, Rustenburg O.
1 inch	Webber, Improved Bancroft, Watt's Long Staple.
12/16th inch	Early King.

7. ENTOMOLOGICAL.—Cotton in the Rufiji district seems to be particularly free from insect pests and in no case, with the exception of the ratooned cotton on the Experimental Station, was any cotton crop so seriously affected as regards yield or quality by insect pests as to render its cultivation unprofitable. This satisfactory position is no doubt due in large measure to the enforcement of the Cotton Rules, specially designed to combat the most prevalent species of insects affecting the quality of the cotton in this country. Notes on those most prevalent on the station follow: —

Stainers (Dysdercus spp.).—These were the principal pest in numbers. They made an early appearance in the ratooning experiment and remained till the last cotton was uprooted and burned. They spread from

one experiment to another. The following tables show the incidence of these insects in planted and ratooned cotton growing in adjacent experiments, the former being the first planted plots of the time of sowing experiment. As the ratoons had made but little growth during the hot dry weather at the close of the previous year, their commencement of vigorous growth coincided with the planting of those plots. The total number of insects counted on five plants is given:—

Ratooned Cotton.

Month of examination	Number of Stainers per plant (average of five plants)	
	Adults	Nymphs
February	24	Nil
March	12	138
April	29	816
May	Nil	17
June	1	1
July	5	3

Planted Cotton.

Month of examination	Number of Stainers per plant (average of five plants)	
	Adults	Nymphs
February	Nil	Nil
March	6	Nil
April	3	43
May	Nil	2
June	Nil	Nil
July	Nil	Nil

Four host plants were noted, three of them, Okra, Roselle and Kapok being semi cultivated plants. The other host was the Baobab tree, and numbers of the insects were observed feeding on its pods at a time when there was no cotton growing.

Jassid.—This insect at first gave the indication that it might prove to be a primary factor to be taken into account in judging the suitability of types for this area but this surmise was not maintained. As the season advanced the insect rapidly disappeared, being most prevalent during the wet month of April. As the plants neared maturity it was practically non-existent. The situations in which it was of most frequent occurrence and did the most damage were, firstly, where plants were crowded together because of insufficient thinning; secondly, where seed had been planted in poor soil or in hollows; and thirdly, where the plants were shaded by trees or other taller crops. On the Experimental Station it was most prevalent in the time of sowing experiment and spread from plot to plot in a manner similar to the stainers. Resistance to the insect seemed to be much bound up in the general health and vigour of the individual plants and varieties,

although pubesence of leaves and stems seemed to render the plant less liable to attack. The behaviour of the varieties and Mp selections is detailed below, and it will be noted that those which proved to be the most vigorous and healthy and most at home in the Rufiji soil and climate were the least affected.

Nature of attack	Variety or Selection
Little effect at all stages of growth ...	Uganda 17, Watt's Long Staple, Mp 4/2 Mp 12, Mp 13/3, Mp 9.
Attacked in early stages of growth but later overcome attack	Early King, RM 53, RM 68, RM 90, Improved Bancroft.
Rather severe attack in all stages of growth	Griffin, Mp 19, Mp 8 1, Mp 9 2 Uganda.
Severe attack in all stages of growth ...	Webber, Foster X Whitehall, Rustenburg O.

Boll-worms.—Three species of boll-worms were observed but none were present in sufficient numbers to cause serious damage. The most prevalent was the pink boll-worm. This occurred in the greatest numbers on the Experimental Station in the ratooned and adjoining plots. The remaining two species, American and spiney boll-worms, occurred in very small numbers but were widely distributed and were observed feeding on other malvaceous plants, such as Okra and Roselle.

8. MYCOLOGICAL.—Owing probably to the dry season fungous diseases were not very prevalent. The following table gives the names of fungous diseases identified by the Mycologist and the part of the plant attacked:—

Disease	Part of plant affected	Common name
Ramularia areola	Leaves	Areolate mildew
Bacterium malvacearum	,,	Angular leaf spot
Kuehneola gossypii	,,	Rust
Nematospora gossypium	Lint	Yellow stain

All the diseases mentioned above were common but none assumed serious proportions. The leaf diseases were most common in damp localities or where plants were shaded, and the staining of lint was associated with insect attack. All the varieties and selections suffered from fungous diseases, but none severely, with the exception of Early King.

THOMAS M. CAIRNS,
Cotton Investigator.

IBADAKULI AGRICULTURAL STATION.

Shinyanga District.

The year under review has been the worst recorded for seventeen years. The rainfall was poor and its distribution unfavourable, as is shown by the following records for 1929, in millimetres:—

January	23·7
February	64·2
March	88·7
April	30·6
May	1·8
June	1·8
July	9·2
August	2·2
September	Nil
October	35·2
November	44·0
December	170·0
Total	471·4 millimetres
	18·7 inches

The average annual rainfall over the area in which the station is situated is over thirty inches.

2. The area of the station was increased to 300 acres. The land was ploughed, cross-ploughed and harrowed.

3. A hedge of Euphorbia was planted around the nursery and a hedge of pigeon pea around the experimental plots to act as a wind break.

4. During the dry season the only water available was from a well sunk in the river bed. The water contained a high percentage of salts and the utmost difficulty was experienced in keeping young seedlings alive.

5. The area of all plots was one-fortieth of an acre and the experiments were carried out in quadruplicate.

6. In addition to the experimental plots propagative plots of Potchefstroom Pearl and White Cango maize, Tepary beans and groundnuts (Virginia Bunch variety) were planted. A large area was also planted up with a mixture of maize, velvet beans, bonavist beans and sunflower for ensilage. The results of the various experiments follow:—

7. Cotton: Time of Sowing.

Date of planting	Monthly Rainfall in millimetres		Comparative yield
15.11.28	November, 1928 ...	61·5	84
30.11.28	December ...	198·0	80
15.12.28	January, 1929 ...	23·7	96
31.12.28	February	64·2	100
15.1.29	March	88·7	84
30.1.29	April	30·6	75
15.2.29	May	1·8	66
2.3.29	June	1·8	71
16 3.29	July	9·2	61
30.3.29	August	2·2	58

8. The results of two years' experiments agree with field observations taken over a period of four years and are as follows:—

Year	Optimum time of sowing
1927/28	22nd December
1928/29	31st December

9. *Cotton: Distance of Sowing.*—The experiment was carried out with cotton grown on the flat and on ridges.

Spacing in inches	Comparative yields		Yield in lb. per acre	
	On the flat	On ridges	On the flat	On ridges
36″× 6″	89	91	680	750
36″× 9″	93	98	710	800
36″×12″	92	85	700	700
36″×15″	89	87	680	710
36″×18″	92	89	700	730
36″×24″	93	87	710	710
30″× 6″	100	100	760	820
30″× 9″	92	96	700	790
30″×12″	95	94	720	770
30″×24″	96	91	730	750

10. The results of the previous season's experiments, as compared with those above, are of interest, in view of the fact that the 1928 season was a good one for rainfall, and 1929 a very poor one. The 1928 results are given below. The plantings were on the flat only and all spacings between the rows were thirty-six inches.

Spacing in inches	Plants per hill	Comparative yields	
		1st series	2nd series
6 inches	1	53	44
9 ,, ...	1	46	44
12 ,, ...	1	72	56
15 ,, ...	2	65	81
18 ,, ...	2	100	100
24 ,, ...	2	89	92

11. *Maize: Comparative Trials.*—Throughout the district the maize crop was a complete failure. The results of last year's experiments under a good rainfall indicated that Potchefstroom Pearl gave the best results, whereas this year White Cango yielded twenty per cent. heavier than Potchefstroom Pearl. This year was, as previously stated, exceptionally dry and where Potchefstroom Pearl failed completely in the latter plantings, White Cango withstood the drought and gave comparatively good results.

Variety	Date of Planting	Yield in lb. per acre
Potchefstroom Pearl	15.12.28	500
White Cango	,,	400
Potchefstroom Pearl	31.12.28	450
White Cango	,,	310
Potchefstroom Pearl	15.1.29	110
White Cango	,,	170
Potchefstroom Pearl	30.1.29	120
White Cango	,,	160
Potchefstroom Pearl	15.2.29	200
White Cango	,,	310
Potchefstroom Pearl	2.3.29	Failure
White Cango	,,	820
Potchefstroom Pearl	15.3.29	Failure
White Cango	,,	760
Potchefstroom Pearl	30.3.29	Failure
White Cango	,,	,,

12. *Maize: Distance of Sowing.*

Variety	Spacing	Yield in lb. per acre	Comparative yields
Potchefstroom Pearl	3′ × 2′	1,020	87
	3′ × 3′	1,040	89
	4′ × 1′	1,170	100
	4′ × 1′6″	1,090	93
	3′6″ × 1′	920	79
White Cango	3′ × 2′	760	74
	3′ × 3′	880	85
	4′ × 1′	1,030	100
	4′ × 1′6″	810	79
	3′6″ × 1′	600	58

13. In both the previous year's experiment under a good rainfall, and in this year, with a poor rainfall, a spacing of four feet by one foot gave the maximum yield. All the plots were sown on 15th December, 1928.

14. *Groundnuts: Time of Sowing.*—The spacing kept was thirty inches by nine inches.

Date of planting	Days to maturity	Yield per acre in lb.	Comparative yield
26.12.28	108	1,030	100
15.1.29	93	990	96
30.1.29	—	620	60
15.2.29	—	190	18
2.3.29	—	230	22
15.3.29	—	200	19
30.3.29	—	120	12

15. This year the heavy rains failed but from the above and previous experiments, one would conclude that groundnuts require to be planted as early as possible after the rains have set in. It will be observed that the results agree with those for the similar experiment with cotton (paragraph 7).

16. *Groundnuts: Distance of Sowing.*—All plots were planted on 16th December, 1928.

Spacing	Yield in lb. per acre								Average
	1	2	3	4	5	6	7	8	
2′ 6″×9″	360	440	360	360	440	600	600	520	460
3′ 6″×9″	640	520	800	760	560	880	720	560	680

17. In this year of low rainfall, the wider spacing gives the best results. In the good crop year of 1928, the average figures were respectively 975 lb. and 850 lb., the narrower spacing thus giving the better results.

18. *Sorghum and Millets: Variety Trials.*

Variety	Days to maturity	Comparative yield
Kilinyali	192	100
Bonganhilo	163	59
Dwarf Yellow	156	61
,, Hegari	155	46
Feterita	147	56
Bulrush Millet	173	98
Panicum frumentaceum ...	110	20
Western Cold Millet	Failure	—
Early White Milo	114	69

Variety	Days to maturity	Comparative yield
Black Amber	114	31
Early Sumac	130	33
Red Amber	114	65
Leoti Red	130	21
Hungarian	Failure	—
Gold Mine	Failure	—
White Wonder	Failure	—
Sudan Grass	154	93
Freed Sorghum	Failure	—

19. Kilinyali again proved the best variety for this district, as in 1928.

20. *Beans: Variety Trials.*

Variety	Days to maturity	Average yield in lb. per acre	Comparative yield
Sugar Beans	died off after flowering		
Pink Hopi	128	180	18
Brown Hopi	128	280	27
White Hopi	202	927	90
White Hopi	156	420	41
Mat Beans	173	1,026	100
Tepary Beans	81	105	10

FODDER CROPS.

21. *Sudan Grass.*—An experimental plot of Sudan grass was broadcasted and cut for hay. The first cutting gave 2,130 lb. of green grass per acre and 985 lb. of hay. The second cutting gave 1,315 lb. of green grass per acre and 685 lb. of hay. No further cuttings were taken but the plot was left to see if the Sudan grass would withstand the drought. It remained green all the year and a further crop of hay can now be cut from it.

22. *Berseem or Egyptian Clover.*—Experiments were carried out with this clover, the seed being sown in line and also broadcasted. Plots were planted on 15th December, 1928, and on 3rd February, 1929, but although good germination was obtained there was no growth afterwards. The plants withered up and died. An endeavour was made to save a few plants by watering each evening, but this was of no avail.

23. *Subterranean Clover.*—The above experiments were repeated with this clover. The plants reached a height of three to four inches and then withered up and died.

24. *Kudzu Vine.*—A total of 150 plants was reared. These have been transplanted on the Agricultural Sub-station, Ibadakuli.

25. *Karroo Bush.*—Only one bush survived under true field conditions, but in the nursery twenty-nine bushes were reared. These have been transplanted on the Agricultural Sub-station, Ibadakuli.

26. *Grasses.*—The following grasses were planted in the nursery:—

Texas Grass
Warrego Summer Grass
Native Millet (*Panicum decompositum*)
Giant Panic
Coolah Grass.
Queensland Grass
Rare Blue Grass
Brown Tapor Sugar Grass
Weeping Love Grass
Blue Mitchell Grass

27. Native millet and brown tapor sugar grass were a failure. The other grasses gave good germination but with the exception of giant panic and coolah grass the others made very little growth.

A. S. Richardson,
Acting Senior Agricultural Officer,
i/c North-Western Circle.

BOTANIC GARDENS.

Dar es Salaam.

Seed and Plant Distribution.—The following table shows the plant and seed distribution during the year:—

Plants	Seeds		Cuttings (bundles)	Bulbs and rhizomes
	Packets	Bulk		
2,030	65	83 lb.	9	110

The figures for plants include dry-land fodder plants raised in the gardens for growing in the semi-arid districts of the Territory. The eighty-three pounds of seeds comprise cover and green manure crops and shade trees, distributed chiefly to planters within the Territory. Countries and stations receiving plant material from the gardens were:—Royal Botanic Gardens, Kew, England; Department of Agriculture, Ceylon; Department of Agriculture, New South Wales; Department of Agriculture, United States of America; Botanic Gardens, Buitenzorg, Java; Usumbura, Belgian Congo; Imperial Institute, London; The Rockefeller Institute, New York; Ministry of Agriculture, Egypt; Kambole Mission, Northern Rhodesia; Kutch, India; The Governor of Nyasaland.

2. Plant and seed introduction into the gardens was as follows:—

Plants	Seeds (pkts)	Cuttings (bundles)
33	110	2

These include a collection of orchids from Sikkim and cacti from Mexico. Palm seeds were received from various sources for improving the palm collection in the gardens. The following contributed seeds and plants during the year:—Department of Agriculture, Ceylon; The East African Agricultural Research Station, Amani; James Allen, New Mexico; Forestry Department, South Africa; Department of Agriculture, United States of America; Department of Agriculture, Gold Coast; Department of Agriculture, New South Wales; Botanic Gardens, Georgetown, Demerara; Botanic Gardens, British Guiana; Department of Agriculture, Federated Malay States; Forest Service, Palestine; Lloyd Botanic Garden, Darjeeling; Botanic Gardens, Buitenzorg, Java; Honolulu Hawaii; Ministry of Agriculture, Egypt; Royal Botanic Gardens, Trinidad.

3. The cover crops grown for seed production during the year were *Calopogonium mucunoides; Tephrosia Hookeriana; Tephrosia purpurea; Crotalaria striata.* Fibre plants grown for the same purpose were three strains of *Hibiscus cannabinus*, including a local strain and one from Pusa; *Hibiscus Sabdariffa* var. *altissima; Crotalaria juncea.* Supplies of seed of the above plants are available for distribution in limited quantities.

As has been stated, further experience has shown that the growing of Hibiscus fibres as a native industry is not practicable at the present stage, owing to the time and labour involved in the extraction of the fibre, the scarcity of water suitable for retting and the fact that other cash crops are more suitable for native cultivation.

4. *General matters.*—The newly-planted avenue trees of *Peltophorum ferrugineum* and of the royal palm, *Oreodova regia*, are showing great promise and these will eventually be a decided improvement over the former avenues of *Albizzia Lebbek*. The avenue trees received attention as necessary. Three hundred and eighteen trees were taken down during the year. Government House Grounds, the open spaces in the township and war cemeteries have been maintained in good condition. It is to be recorded that there is a slight improvement in the condition of the coco-nut plantations in and near Dar es Salaam. The first-order meteorological station has been fully maintained, weekly and monthly returns being rendered.

5. Assistance was given at the Agricultural and Industrial Exhibition. Various exhibits were shown, notably a collection of Hibiscus and other locally grown fibres, live plants of species of Aleurites (yielding tung oil) and Hydnocarpus (the oil of which is used for treatment of leprosy). Plants showing different methods of budding and grafting were also exhibited.

6. *Plant Importations through Dar es Salaam.*—This work continues to increase and the disposal of consignments of plant material inspected under the Plant Pest and Disease (Import) Regulations, 1923, was as under:—

Total inspected	Passed for importation	Rejected
341	300	41

T. H. Marshall,
Head Gardener.

REPORT OF THE ENTOMOLOGIST.

The Entomologist has been resident during the period of the report. The Assistant Entomologist was absent on vacation leave from 21st September, 1929, until 28th March, 1930.

2. Dr. Guy A. K. Marshall, Director of the Imperial Bureau of Entomology, visited the Laboratory in September, 1929.

3. *Sericulture.*—Mr. Paul Küller, of the African Silk Corporation, visited the Territory in November, 1929, and was met in Dar es Salaam for full discussion of the future activities of the Corporation.

4. Mr. Norton Breton, Chairman of the Advisory Committee on Silk Production of the Imperial Institute, visited various districts of the Territory during the period September to December, 1929, and summarised his conclusions as follows:—

(i) Mulberry of the right variety for feeding silkworms will grow profusely in many parts of the Territory.

(ii) Climatic conditions appear to be satisfactory in as many places as are necessary for sericulture to become an important industry.

5. Specimens of brocade, tie cloth and ribbon woven from the 1928 cocoons reared at the Laboratory were an important and interesting feature of the Agricultural and Industrial Exhibition held in September at Dar es Salaam. The specimens were prepared under the auspices of the Imperial Institute. The technical reports on the 1928 cocoons by various branches of the silk trade received through the Advisory Committee on Silk Production of the Imperial Institute were commented on as follows by the Director of the Institute:—

"The results of the investigation may be regarded as satisfactory and promising and as indicating that a marketable silk of good quality can be produced in the Territory."

Absence of staff on anti-locust work has prevented further silk work being undertaken during the year.

6. Mulberry of Chinese, French and Italian stock, of *Morus alba* and *Morus indica*, continues to make excellent growth at the Laboratory trial plots. Examination of a backward block of mulberry showed upon its being dug up for examination the necessity for early and careful transplanting prior to hardening of root tissue, *i.e.*, when cuttings have a well developed but fibrous pliable root system (three to four months). Thick hardened roots, split and broken in transplanting, fail to develop the deep, searching root system essential for drought resistance. It is also evident that twisting or bending of aged or thickened roots at time of transplanting handicaps development. The block was also badly affected by root eelworm *(Heterodera radicicola).*

7. *Apiculture.*—The export of beeswax for 1929 was 6,721 cwt., a very pronounced decline from the preceding years, attributable to the exceedingly low rainfall throughout the Territory.

COMPARATIVE FIGURES FOR EXPORT OF BEESWAX FROM VARIOUS PORTS DURING THE YEARS 1926 TO 1929 INCLUSIVE.

Port of Entry	1926		1927		1928		1929	
	Cwts.	Value	Cwts.	Value	Cwts.	Value	Cwts.	Valve
		£		£		£		£
Dar es Salaam* ...	3,834	30,143	9,821	71,712	8,185	59,793	4,987	36,094
Mwanza	183	1,260	454	3,177	262	1,783	—	2
Lindi	1,921	15,206	855	6,176	1,169	8,155	1,619	11,327
Tanga	49	388	12	98	59	420	29	166
Kilwa	157	1,166	13	93	128	857	72	477
Other Stations... ...	3	16	14	107	12	71	14	83
Total each year	6,147	48,179	11,169	81,363	9,815	71,079	6,721	48,149

*Including Salale.

The monthly price of the best Tabora beeswax at Dar es Salaam has varied from Shs. 41/- to Shs. 46/50 per frasila (16 kilograms).

8. Plots of buckwheat *(Polygonum fagopyrum)*, white clover *(Trifolium repens)* and niger oil *(Guizotia abyssinica)* were planted at the Laboratory for observation as to their suitability as honey sources. The weather conditions were unsatisfactorily dry. Buckwheat made a good stand but bees ignored it entirely. On Mt. Kilimanjaro, however, buckwheat as a green-dressing intercrop in young coffee, exercised its customary attractiveness and bees appeared particularly fond of it. Clover germinated and started well but failed to stand up to the drought. The niger oil was equally unsatisfactory under the conditions. Both of the latter should do well in the damper conditions of the Northern and Tanga Provinces.

9. *Lac Culture.*—As a consequence of reference in former German literature to the subject, enquiries have been received as to the possibilities for lac culture in the Territory. Enquiry in German official sources has elicited the information that while this culture was anticipated, no "seed" stick lac was ever actually introduced. While many suitable indigenous host trees for lac occur in the Territory, and while conditions generally would prove suitable, it is to be feared the predatorial caterpillars of such lepidoptera as *Eublemma costimacula* Saalm., *Spalgis lemolea* Druce, etc., would prove extremely destructive of the lac.

10. *Coffee Pests.*—In the preceding report, the hypothesis was put forward that the coffee bug *(Antestia lineaticollis* St.) might prove to be the transmitting agent of a definite disease organism in developing coffee bean, as examination of bean failed to reveal any suggestion of disease invasion at the stem or blossom end of the cherry, but bean showing internal tissue disturbance was always associated with distinct evidence of antestia puncturing. The Mycologist has succeeded in isolating an organism determined as *Nematospora coryli* from diseased bean, and present evidence supports the theory that antestia is responsible for an internal rot of coffee bean in manner similar to Dysdercus in cotton.

11. Cage experiments are being undertaken for further study of antestia control with poison syrups (*vide* Annual Report 1928-29, para. 12). A poison equally effective as arsenite of soda but less injurious to vegetation is being sought.

12. As the injurious nature of arsenite of soda renders it essential that the minimum effective quantity be used in sweetened spray preparation against antestia, it was considered desirable to enquire regarding the composition of average samples on the market. Four samples of arsenite of soda from various sources were examined by the Imperial Institute showing the following composition:—

	A		B		C	D	
	As received	Roughly crushed	As received	Roughly crushed	As received	As received	Roughly crushed
	Residue per cent.	Residue per cent.	Residue per cent.	Residue per cent.	Residue per cent.	Residue per cent.	Residue per cent.
Extraction for one hour with water at about 20°C.	0·25	0·24	8·13	9·19	0·18	0·59	0·65
" " " with water at about 100°C.	0·12	0·15	5·02	5·63	0·09	0·52	0·58
Arsenic Trioxide, As_2O_3 (Total %)		44·42		76·80	77·44		78·38

Enquiry of manufacturers indicates that for antestia control work it may be fair to stipulate for an arsenite of an analysis of eighty per cent. of arsenious oxide (As_2O_3) with a residue insoluble in cold water of 0·2 per cent. and of 0·1 per cent. in hot water.

13. A cecidomyiid maggot caused sterility and fall of coffee blossom in the second blossom flush of December, 1929, in Kilimanjaro. Infestation of the later blossom could not be traced and material for study and rearing when cessation of major anti-locust activities permitted of this was not procurable. The activities of the maggot give a distinct lop-sided goose-head shape to blossom, associated with darkened discolouration of the corolla and anthers.

14. *Tea Pests.*—No insect pests have as yet been submitted from the new tea areas. It is, however, worthy of note that the cause of so-called "mosquito blight" *Helopeltis bergrothi*, Reut. has been collected on coffee in Usambara.

15. *Cotton Pests.*—Cotton was again, as in 1928, a particularly clean crop. Acclimatisation of seed and retention of early first class seed on the markets for planting has largely contributed to this improvement in field standard of Territory cotton. It is regretted this undoubted high field standard of seed cotton may not be adequately reflected in the total percentage class figures for the Territory as with increased crops to handle, natives are disinclined to exercise similar care in handpicking (house sorting of crops) as in the initial years.

16. On the occasion of the visit of the Director of the Imperial Bureau (in September) a thorough laboratory examination of cotton bolls collected during the tour throughout the Morogoro-Kimamba-Kilosa area was made and showed the incidence of pink bollworm *(Platyedra gossypiella*, Saund.) to be 1·7 per cent. of boll locules. Reference to the initial entomological reports on cotton pests made in 1922 shows that the incidence in the same region then varied from thirty to forty per cent. in certain districts and to eighty per cent. in others. The greatly improved condition is attributable to the curtailment of the cotton season and improved observance of a cotton dead season in the subsequent years. Another pest which has practically disappeared from the cotton fields under the improved conditions, is the weevil, *Apion xanthostylum* Wagn. This pest in 1922 destroyed by basal stem attack up to seventy-five per cent. of the stand in cotton blocks of the Morogoro Experiment Station, and infestation in the torus of bolls was in many districts as high as forty per cent.

17. Recent work in the United States of America in the application of micaceous dusts for caterpillar control gives interest to the following facts:—

It has for some years been recognised in the Morogoro cotton area that seed cotton passed through rotary openers (or beaters) is cleaned of a high percentage of the contained pink bollworm, but that worm rescued from the dusting refuse (containing soil material) fails almost entirely to pupate, and moth, if pupæ are formed, to emerge. The soils of the area are highly micaceous, originating in part from mica bearing schists of the Ulugurus.

18. Throughout the major cotton producing areas of the centre and coast of the Territory, the bolling season of Kapok *(Eriodendron anfractuosum)* is December to February, when cotton plants have been uprooted and when increase of stainer *(Dysdercus* spp.) consequent upon shedding of kapok seed is unable to have any soiling effect on cotton lint. It has been decided that the growing of kapok in cotton areas is permissible.

19. *Storage Pests.*—In view of the importance of *Lyctus brunneus* Steph. to timber storage interests, it is advisable to record it as occurring in the Territory attacking various of the softer timbers or the sap wood of the hard timbers.

20. The Drug Beetle, *Araecerus fasciculatus* DeGeer, which has recently received investigation as a storage pest by Munro and Thomson on behalf of the Empire Marketing Board, was initially recorded in the Entomological Report of 1922 as attacking cocoa in the pod on the tree. The infestation was particularly heavy as the cocoa pods were badly affected with pod rot, which permitted ready ingress of the adult beetles. Wood peckers had also driven holes into the diseased pods and it is readily appreciated that cocoa in process of drying in the vicinity would have been heavily infested. It is doubtful if *Araecerus*

can, or attempts to, procure entry into an absolutely sound cocoa pod to effect field infestation. On well conducted plantations where disease is controlled and pods systematically collected, the dry or drying pod attractive to *Araecerus* does not exist.

Coffee allowed to dry up as *buni* on the tree also provides breeding ground in the field. Coffee seed is often attacked in store and the "grub" may cause undue alarm as likely to be confused by the uninitiated with that of *Stephanoderes*.

21. *Locusts*.—The present visitation of the Desert Locusts, *Schistocerca gregaria* Forsk. may be conveniently divided into four periods associating these with the date of invasion of flying locusts from across the northern border of the Territory:—

(a) April-May, 1928.—No egg-laying occurred and the fliers went back across the northern boundary of the Territory.

(b) November-December, 1928.—Egg-laying in Makania, South Pare and West Arusha, necessitating an anti-locust campaign at Makania.

(c) January, 1929.—Egg-laying in East Kilimanjaro and Makania, Hedaru and Mkomasi in South Pare. Extensive anti-hopper compaign in all these areas.

(d) November, 1929.—Egg-laying of a scattered description in South Longido, Eastern Kilimanjaro, near Korogwe, Usambara and Handeni District; concentrated egg-laying in Ngulu, North Pare, on all sides of South Pare (Makania, Hedaru, Kihurio, Gonja, Kisiwani), at Kivingo, Mnazi and Mpatwa at foot of Western Usambara, at Mkumbara Masinde, Mombo Makuyuni at foot of Southern Usambara and generally over the Lushoto uplands at altitudes reaching over 5,000 feet.

In the (a) and (b) invasions, the fliers were of the yellow sexually mature phase; in the (c) invasion, of the red sexually immature phase; and in the (d) invasion, of the yellow phase. The duration of the red phase in these latitudes is two months, and it has been shown that three generations are possible per year.

22. The Entomologist has been in executive control of the (d) campaign in the north-eastern area and in control generally of advisory work. While flying locusts again penetrated southwards of the Central Railway as in the (b) and (c) invasions, activities of the (d) campaign outside of the north-eastern area consisted principally in scouting of movements of the adult swarms. Egg-laying occurred north of a line five degrees thirty minutes south latitude and east of thirty-seven degrees east longtitude.

23. The invading locusts again advanced southward through the gaps in the northern mountain chain and chose for loci of major oviposition the similar areas as in the (b) and (c) invasions. The topography of country chosen may be described as without exception the worst in the Territory from the point of view of facility for conducting an anti-locust campaign. It is densely covered with thickets of sansevieria, euphorbia, aloes, acacia bush and twining forms of other xerophytic vegetation.

Veritable tunnels had to be cut through the impenetrable clambering vegetation to get at islands of hoppers with now and again the excitement of a rhino. or buffalo encounter to add to the excitement or misery of it all. With the rains of November, such normally droughty areas send forth heavy grass growth and various succulent ground weeds *(Portulaca,* etc.) of which locusts are exceptionally fond. The short season rains of November have continued without intermission through to the great, or *masika,* rains, resulting in an excess of rank vegetation throughout the northern districts most liable to a recurrence of locust activity.

24.—*Methods of Hopper Destruction: (a) Bran-baiting.*—This method practised in the northern vegetationless areas of Kenya and the Sudan is quite out of the question with the superfluity of alternative food available; moreover, there is the difficulty of distribution, and further, the bait falls down into the impenetrable thickets and deep grass and weed growth and is lost. Bran-baiting would be practicable at certain seasons in the open plain areas, where altogether an anti-locust campaign would be a much simpler affair.

(b) *Spraying with arsenite of soda solution.*—Work with the lorry units (consisting of a motor pump with four 100-foot leads of hose made by Drake and Fletcher, Maidstone, and corrugated iron water and poison drums) proved extremely effective and economical. While two ounces per *debe* (four gallons) are effective on young hoppers, it is considered, for convenience and in view of the inadvisability of leaving of discretion in such matters to the subordinate staff, that five ounces should be used throughout. This strength is safely adequate for all wingless stages, and allows a margin for careless weighing or mixing.

(c) *Dusting.*—Arsenite of soda dust applied from five-pound canisters (with holes punched in the lid by means of a perforator) as advised in South Africa, or by means of dusting guns ("Niagara" pattern) is also an extremely effective method. The dust prepared by Kynochs of South Africa is the best dusting quality on the market, but it is possible even this upon closer study will be improved. It is as yet considerably heavy in physical texture as compared with the dusting qualities of calcium arsenate prepared in the United States of America for cotton and sugar-cane dusting by aeroplane. The arsenite is inclined to choke the throat of the present types of dusting guns. Enquiries have been addressed to the Imperial Institute (Chemical Department) as to qualities of calcium arsenite on the British market which may show improvement for this class of work—this in view of recent work by Cowan against the Mormon Cricket in Montana. Sodium arsenite also has the fault of deliquescence and concretion if containers are not properly shut, particularly in damp weather, and when left even in small amounts in the dusting guns, clogs up the machines and eats out the brushes. The admixture of lime with arsenites as an economy and to act as a dusting filler or carrier is not applicable in this Territory. The cost of suitable lime is such that, with the cost of mixing, little economy would, it is considered, be effected as compared with applying straight arsenite of soda. The relation of atmospheric conditions to the degree of effectiveness of arsenite dust is suggested as a point meriting fuller study.

(d) *Barriers.*—Galvanised metal strip (3 mm. by 33½ cm.) was procured to meet emergency in open conditions where its use might prove possible and advantageous for barrier and pit construction. All invaded country was of such a rough thicketted nature, however, that its application was quite out of the question. The cost of such barrier material would be approximately Shs. 25/- per 100 yards.

(e) *Flamers.*—With a recurrence of anti-hopper operations in the thicket country of South Pare, it was considered that the use of flame might be tried. Twenty new "Four Oaks" flame-throwers were procured from the Kenya Government. The method (where machines permitted of well-organised attack) is extremely effective in dense thicket country. Beaters can by combined action concentrate hoppers or organise a "march" and prepare the way for flame attack in otherwise impenetrable country. Experiments were tried with a smaller nozzle aperture, 1/32nd in. instead of 1/16th in., and with variations in mixtures, but the Palestine aperture, 1/16th in., and mixture (two parts crude oil, one part petrol) could not, it is considered, be improved upon. It is considered the flame-throwers used could be improved in the following points:—

(i) improved connection of delivery outlet pipes;
(ii) copper cone too heavy for existing gauge of extension rod;
(iii) the mixture causes distortion and wear of rubber composition valve balls and rubber washers.

(f) *The use of Natives.*—So long as anti-hopper work falls to be undertaken in country like South Pare, Usambara foothills and overgrown sections of Masailand, considerable reliance must necessarily be placed in a large native force. Their work must consist in the circling and beating of hoppers in this difficult country or in the slashing of bush to permit of ingress therein for application of chemical methods. In competent hands, the chemical method backed by a well-organised assisting native force is deadly and expeditious. The training of native spraying and dusting gangs is a matter for keenness and patience on the part of practically-minded locust officers.

25. *Miscellaneous.*—There was an outbreak of the Army or Mystery worm, *Laphygma exempta* Wlk., over practically the entire Territory in late January and February. The caterpillars injured young maize, sorghum and native crops in the early growing stage. Cotton was not observed to be affected. The pest and its parasites were referred to in the Annual Report for 1926. The "rain of worms" is a phenomenon well known to the natives and is viewed as a sign of a year of plenty.

The insect numbers appear more frightful than the actual damage later indicates to be warranted. To cope with such outbreaks, measures would require to be too extensive to justify the cost. Trenches thrown up around maize fields on the sides of the worm, and policed by natives, can effect protection against invasion.

26. Description of the following insects of economic importance and new to science have been published during the year:—

In Series 10, Vol. 4 of the "Annuals and Magazine of Natural History."

Page 249, September, 1929:—

Sarcophaga benefactor Malloch., parasitic on the Desert Locust, *Schistocerca gregaria* Forsk.

Page 515, November, 1929:—

Coccinellidae:

Endochilus meridionalis Sic.
Scymnus (Nephus) castaneicolor Sic.

Page 465, November, 1929:—

Coccidae:

Pseudococcus bukobensis Laing. on coffee *(Coffea arabica).*
Paraputo ritchiei Laing. on wild tree (unknown).
Ctenochiton arborescens Laing. on coffee *(Coffea arabica).*
Chionaspis tursioides Laing. on thorn bush (unknown).
Chionaspis ritchici Laing. on coffee *(Coffea arabica).*
Aspidiotus andersoni Laing. on Oleander *(Nerium oleander).*
Chrysomphalus rossi Mask. var. *musae* Laing. on banana *(Musa sapientum).*
Lepidosaphes punicae Laing. on pomegranate *(Punica granatum).*

In Bulletin of Entomological Research, Vol. XIX, Part 4.

Page 391:—*Curculionidae:*

Tanymecus arushanus Marshall, on cotton foliage.
Systates labenatus Marshall, on cotton foliage.

Archibald H. Ritchie,
Entomologist.

REPORT OF THE MYCOLOGIST.

During the year the Mycologist was on tour for over seven months. Mycological work was interrupted by locust defence duties, commenced on 11th February, 1929, and continued until 25th July, 1929. Duties in connection with the Agricultural Exhibition in Dar es Salaam were undertaken from 27th August to 9th September, 1929. A tour through the coffee areas in the Northern Province extended from 13th December, 1929, until 8th March, 1930.

2. Advisory work on diseases of crops has steadily increased, as planters have taken advantage of this service of the Department. Increased contact, through correspondence, has been effected with all areas; by this means, urgent problems have been revealed which could not come under direct observation.

3. Several field experiments have been planned and carried out with the co operation of coffee and sisal planters. Laboratory studies have been curtailed and interrupted by the necessity for touring. Of the major crops of the Territory, coffee and sisal have received particular attention; the results are recorded below.

4. Unless otherwise stated, the identification of each fungus mentioned in the Annual Reports has been made or confirmed by the Imperial Bureau of Mycology, Kew, thus ensuring the greatest degree of accuracy and a uniformity in nomenclature.

5. The work of the Laboratory has been brought to the notice of planters by means of three addresses at meetings of Planters' Associations, by some sixty personal visits to plantations, and through five articles published in the native and non native press; this is in addition to correspondence and advice given through the District Agricultural Officers. Representative material of many of the economic plant diseases in the Territory has been augmented during the year and is available for reference.

DISEASES OF COFFEE AND COFFEE SHADE TREES.

6. *Coffee Bean Disease.*—A disease hitherto unexplained has been investigated near Moshi from December, 1929, onwards. Briefly, the following are the outstanding results:—The disease takes the form of blackening, drying and shrinking of the coffee beans; the skin of the fruit is unaffected. A varying number of cherries may contain diseased beans: on one plantation in December, 1929, as many as 295 cherries in 300 were found with one or more discoloured or shrivalled beans. The yield on this plantation was twenty-eight tons, whereas three hundred had been the estimate of the crop; this discrepancy is, however, exceptional. By March, 1930, the coffee areas known to be affected were Kilimanjaro, Meru, Usambara and South Pare, in the Northern and Tanga Provinces, and also part at least of the Bukoba Province.

7. Small green cherries become affected, but red cherries at the end of the year, having been open to infection for a longer period, show a larger percentage diseased. It appears that the incidence of diseased

cherries can best be estimated at the end of the growing season, because earlier observations are confused by the presence of the trouble next to be described.

8. The causative fungus is *Nematospora Coryli* Pegl. (ident. W. Nowell). This parasite has a wide host range, particularly among leguminous plants (see Citrus and Beans below). The fungus is spread by means of its spores: these in the case of coffee were shown by experiment at Moshi to be carried from one cherry to another by the coffee bug, *Antestia lineaticollis* Stal. Prof. Zimmermann appears first to have observed an association between "Brown beans" and antestia, as a result of his work in Eastern Usambara in 1903: no fungus was detected, but he has more recently suggested the possible existence of a fungus parasite (see also the Report of the Entomologist).

9. The control measures advocated are (a) to destroy the insect vector, and (b) to reduce the amount of infective material. With regard to (a), the value of sodium arsenite for poisoning the bug has been clearly shown by the Entomologist, but the necessity for spraying with this poison, as a routine practice, is now further emphasised. (b) To reduce the amount of infective material, two practices must be adopted. The first is to pick all ripe cherries without unnecessary delay, these are probably the chief source of infection for the succeeding young crop. Secondly, the growing of other susceptible crops near coffee must be avoided. A list of the known hosts of the fungus under consideration and related species has been compiled, and may be obtained through any officer of the Department. Leguminous plants grown as cover-crops should be cut down before young pods form, until it can be definitely shown to what extent the occurrence of the fungus in these is a menace to coffee, that is, until more is known about the host relationships of the bugs on the various hosts of the fungus, and until the incidence of the fungus in the various cover-crops is more fully known.

10. *Coffee Cherry Fall.*—A disease, very readily mistaken for the one just described, is what may be referred to as Coffee Cherry Fall. Here again, black beans are encountered. In this case, however, no parasite has been observed, and the effect appears to occur even in the absence of antestia. The actual fall of cherries appears to be one symptom of a physiological weakness in the trees; the coffee tree is very prodigal in its production of flowers and fruit, but under some conditions there are indications that it has borne fruit in excess of what it can successfully mature. The excess fruits are denied an adequate supply of sap by the formation of a layer of corky cells; the latter are mealy to the naked eye. This barrier forms at the base of the cherry stalk or at the base of the fruit itself.

11. The cherry may fall early, or it may remain loosely attached for some time. In either case, the cherry skin darkens from the base upwards, and also the beans turn black, either before or after an invasion by saprophytic organisms from the exposed end of the stalk or cherry. The black beans are soft and moist, whereas beans affected by *N. Coryli* are dry and harder; the distinction is slight, but apparently fairly constant. Both forms of black bean are very often present together, in

which case it may be difficult or impossible to distinguish the parasitic form by the unaided eye. The non-parasitic form of black bean disease is known to be present by the number of fallen cherries on the ground.

12. *Coffee Blossom Injury.*—An examination was made in December, 1929, of the blossoms of coffee trees in a restricted area of the Northern Province. These blossoms showed brown discoloration on all the floral parts, and sometimes shrinkage of the organs. Such blossoms had a tendency to fall prematurely. Microscopic examination and culture work indicated that the trouble was independent of any fungus parasite. On the other hand, small fly larvæ were invariably present in discoloured but unopened flower buds. As these were apparently the cause of the trouble, the subject was referred to the Entomologist.

13. In addition to the fungi already recorded from coffee in this country, three others have been observed. These are:—*Phomopsis* sp. on the twigs, *Leptosphaeria coffeicola* Maubl. following *Cercospora coffeicola* B. and C. on the leaves, and *Leptosphaeria* sp., apparently a new species, on the twigs of Arabian coffee. These fungi are probably of little significance.

14. *Root Diseases of Grevillea.—Grevillea robusta* trees, growing as shade in a northern coffee plantation, were found heavily affected by *Armillaria* sp. The neighbouring coffee trees were free from this parasite, thus revealing a considerably greater degree of resistance in this case. On the other hand, a few coffee trees were affected by *Rhizoctonia bataticola* (Taub.) Butl.—already recorded on this host—whereas this parasite was not seen here on the Grevillea. The Armillaria appears to be comparatively rare on Grevillea, possibly owing to insufficient observation, but the drastic results once it is established indicate that the measures recommended for the root diseases of coffee should be immediately applied.

SISAL DISEASES.

15. *A Non-Parasitic "Banding Disease."*—This disease was referred to provisionally in the last Annual Report as a "waterlogging disease." Since, however, the disease has been more recently found on very dry soils also, the earlier name can no longer stand. Information beyond that already recorded follows.

16. During the past year, this disease was observed to have reached destructive proportions on fifty acres of a plantation in the Eastern Province: frequently only the two youngest leaves next the bud were sound. The soil on this area was a very deep and poor sand. In the continued absence of any evidence of a parasitic origin, the subject was treated as a physiological problem. The matter is still under study, but the key to the solution is believed to have been found. In October, 1929, one hundred sisal plants, showing the black bands at the base of at least half of the leaves were taken from the affected plantation, and transplanted in a richer soil. After an interval of five months, it was observed that not one leaf, which had been healthy at the time of transplanting, had developed

the symptoms of the disease. On the other hand, the progress of the injury in a few slightly affected leaves had been arrested, and the leaves were developing normally.

17. It is considered that the only factor common to both the poor dry sandy soil and the soils subject to flooding or lacking adequate drainage is the loss of or absence of nitrates. It is probable that nitrates would be readily leached from the former soil, and formed in insufficient quantity, if at all, in the latter. Until experiments in hand reveal the effect of an absence of each essential element, the following treatments are suggested as a guide to the prevention or control of this disease. For swampy soil the necessity for drainage has already been indicated; where that is impracticable, the land might better be sown with rice. On poor sands, the "body" of the soil should be built up by mulching, or by interplanting with leguminous crops. These, when dug in, would help to retain moisture, and to prevent excessive evaporation; they also supply nitrogen. It is tentatively suggested that this latter treatment may so stabilise the soil moisture content that the trouble known as "sun scorch" may become less common.

18. Since the last published list, *Cucurbitaria agaves* Syd. and Butl. has been identified from sisal leaves. In common with other fungi found on sisal in this country, this species has little significance.

DISEASES OF CITRUS.

19. *Canker and Die-back.*—A destructive disease, particularly of lemon trees, and to a less extent of limes, has been observed in the Morogoro district. It takes the form of die-back of the twigs and branches and of cankers, which extend from ground level to the small branches. External gumming is not a feature of the disease here. Only one fungus is associated with the disease; this is apparently *Physalospora* sp., with its conidial form *Diplodia* sp. also present. The full identification has still to be determined.

20. The canker seems to progress slowly, for the open wound, which runs up one side or up one entire half of the trunk, is bounded by a strong callus. The wound is shallow, and the wood to a depth of half-an-inch is coloured brown by an accumulation of gum. The bark may remain loosely attached over the wound for a considerable time. This bark and also the dead twigs show the small black fruiting bodies of the fungus in large numbers.

21. The treatment suggested has been to cut away all the dead twigs, and whole limbs or trunks, if the disease has progressed far. In some cases it is only necessary to cut away an area of cankered wood. Exposed surfaces should be painted with a heavy coal-tar oil.

22. *Root Disease.*—Two fungi were found on citrus roots in the Northern Province: *Cytospora* sp. on roots of Tangerine orange, and *Armillaria* sp. on lemon.

23. *Dry Rot of Fruits.*—Sweet orange fruits have been found affected by a fungus agreeing with *N. Coryli.* This fungus is known to be transmitted, in the case of citrus, by the bug *Leptoglossus zonatus,* which is no doubt the vector in this country, since it also occurs here.

MISCELLANEOUS DISEASES.

24. *Beans: Yeast Spot.*—A disease observed during the year is Yeast Spot of the seeds of bonavist bean *(Dolichos lablab* L.), and lima bean *(Phaseolus lunatus* L.). The disease is probably being transmitted by green bugs, which are common on these crops and which are known to carry the spores of the fungus elsewhere. The subject is under study.

25. *Cotton.*—A pamphlet dealing with the diseases of cotton in the Territory has been submitted for publication. The fungus *Phyllosticta malkofii* Bubak has been identified from cotton leaves; the *Ascochyta* sp. previously recorded appears to have been a contamination on the leaf-spots caused by this fungus.

26. The following additional identifications have been made during the year:—

MULBERRY: *Sphaeropsis heterospora* Passer, on stems.—A species has since been observed with spores agreeing much more closely with those of *S. Mori* Berl.

SANSEVIERA: *Leptosphaeria* sp., apparently new.

RICE: *Phyllosticta glumarum* Sacc. on leaves and glumes.

WHEAT: *Puccinia graminis* Pers.

PAPAW: *Colletotrichum gloeosporioides* (Penz.) Sacc.

COCONUT: A fungus on the leaves, apparently of a new genus in the *Tuberculariaceae.*

Washingtonia filifera: Diplodia epicocos Cke. and *Phyllosticta palmicola* Winter.

ROSE: *Glœosporium* sp.

Hibiscus esculentus: Colletotrichum Hibisci Pollacci and *Libertella affinis* P. Sacc.

G. B. WALLACE,
Mycologist.